Self-closing valve

The invention relates to a self-closing valve for dispensing an in particular liquid or pasty product, having a valve diaphragm, the valve diaphragm being of convex shape, as seen from the product side, at least in the dispensing region.

A self-closing valve of this type can be gathered from WO 95/26306. It is realized as an injection molding and is incorporated in the end zone of a container closure. The periphery of the curved valve diaphragm is thickened to form a rear-engagement claw, so that, when the convex valve diaphragm pushes out in a manner typical for dispensing purposes, the arresting action achieved in this way is maintained. A stationary supporting element is then located on the product side. The valve diaphragm rests thereon. The valve diaphragm has a central hole-like dispensing opening in which a plug of the supporting element engages with sealing action. Located on the top side of this dispensing region is a holding-down means, realized on a swing lid of the container closure.

German patent application 100 63 522 discloses a self-closing valve, the valve diaphragm of which is stamped out of a planar sheet-like structure. The plate body, which is provided with a slit at the same time, is clamped in a carrier in the manner of an eardrum.

With the knowledge of these given features, it has been an object of the invention to form a self-closing valve of the generic type in a structurally straightforward and functionally reliable manner.

This object is achieved first and foremost in the case of a self-closing valve having the features of Claim 1, this being based on the fact that the valve diaphragm

has, on the periphery, a holding ring which is formed by encapsulation.

A structurally straightforward self-closing valve which is stable during use is achieved in this way. The holding ring acts like a hoop. This ensures the convex shape of the valve diaphragm produced from the planar-surface state. It may be made to have extremely thin walls. Nevertheless, a body which can be handled, and even stored, to very good effect is provided. The shrinkage action which occurs during cooling also assists the dome-shaped deformation of the valve diaphragm.

The subject matters of the rest of the claims are explained hereinbelow with reference to the subject matter of Claim 1, but may also be important in respect of their independent wording. Thus, it is further proposed that the valve diaphragm has a dispensing slit, walls of the dispensing slit opening in a gap-like manner on the product side. The outer fiber in tension assists the corresponding gaping action. In contrast, in the gap base, the slit walls butt against one another, this being assisted by the fiber under compression. The entire arrangement is such that the convex shaping is associated with the inner stressing to which the valve diaphragm is subjected. A uniform cap-like dome is produced as far as the periphery since the valve diaphragm is of convex shape throughout as far as the peripheral region. The holding ring here forms the zone which is not involved in the pushing-out action. It is possible to vary the pushing-out action, which is correspondingly induced by the dispensing operation, by modifying the ring width in order to achieve different actuating forces in the dispensing region. The holding ring is suitably formed in a cross-sectionally U-shaped manner in order fully to enclose an outer periphery of the valve diaphragm. This results in an, as it were, rotationally symmetrical shoe. A

mechanical connection between the holding ring and valve diaphragm which goes beyond the positively locking surround may be carried out such that extending from the holding ring are securing spigots which engage through the valve diaphragm. Through-engagement sections can easily be realized by, for example, a cross-slot. It is further provided that the U-legs of the holding ring are formed to be of different lengths. In one useful application, the U-leg of the holding ring which is directed away from the product is formed to be longer than the U-leg which is directed towards the product. The former has a determining influence on the pushing-out action. For the purpose of positioning the self-closing valve, the invention proposes that the holding ring has a latching recess for latching the valve into a dispensing container. This takes place on the end side. The latching recess is located in the region which is most suitable for stabilizing purposes, and is in the most favorable position, if the latching recess is associated with the U-web. It is further proposed that the valve diaphragm consists of silicone. Depending on structural requirements, it may also be suitable for the valve diaphragm to consist of TPE. In the presence of corresponding features, it is also possible for the valve-forming parts to be arrested on one another without the through-engagement of securing spigots, by the valve diaphragm being produced with the holding ring by two-component injection molding. The invention further proposes that the valve diaphragm consists of a plastics sheet material. It is possible here to make use of many materials which are available on the market. An advantageous development is then achieved by the plastics sheet material being multilayered. The multilayered nature accounts for a variability in the hardness, the resilience, adjustment to product properties, etc. Despite using a material combination of the multilayered plastics sheet material, it is ensured that the product cannot enter into the joints between the layers. One configuration

of even independent importance consists in that, on the product side, the valve diaphragm, in its dispensing region, has a plate part positioned beneath it. This plate part acts as a baffle. It is thus possible, for example in the case of positioning-induced impact loading and even when the container is used as an upside-down container, for the product not to force its way through the dispensing slit. Rather, the plate part functions as a deflector. Under normal dispensing-type loading, the valve diaphragm, in contrast, lifts off from the plate part, so that the product can be dispensed in a deliberately controlled manner. In structural terms, the procedure may be such that the plate part is formed integrally with the holding ring. This takes place, in relation to the valve diaphragm, preferably with material through-engagement by way of the abovementioned securing spigots. An advantageous configuration is achieved in that the plate part is attached resiliently relative to the valve diaphragm. In conjunction with the plate part, a kind of pressure absorbing spring is present. It is further provided that the plate part is attached to the holding ring outside the dispensing slit of the valve diaphragm in the radial direction. At the same time, pressure equalization can take place via said dispensing slit. In addition, the procedure is such that the dispensing slit, along a diameter extent, projects beyond the region of overlap with the plate part. A further feature of the invention is that, on its surface which is directed towards the valve diaphragm, the plate part is of curved configuration in adaptation to the convex profile of the valve diaphragm. This creates the same flow conditions both for the product and in respect of the air equalization in the opposite direction. It is then provided that, with the exception of resilient attachment arms, the holding ring has an outline in plan view which differs from the circular shape of the plate part. It is correspondingly possible to use a configuration of selected cross-section. A non-round

configuration, at the same time, forms a rotation-prevention means. Just a clamping force, however, is generally sufficient as an effective rotation-prevention means. The invention further proposes that the radius of curvature of the valve diaphragm corresponds to 0.8 to 1.4 times the valve diaphragm.

The invention then relates to a container closure which is produced by plastics injection molding and has a self-closing valve, a valve diaphragm and a plate part covering the valve diaphragm on the product side, and it proposes that the plate part is disposed such that it can be moved relative to the valve diaphragm. It is also advantageous here for the plate part to be spring-loaded relative to the valve diaphragm, in this case also functioning as a pressure-absorbing spring. A further variant is achieved in that the plate part is formed integrally with the container closure, and in that the separately formed valve is secured in the container closure. This accounts for a solution which is particularly straightforward to produce. In a further embodiment of this version, it is proposed that integrally formed on the container closure is a swing lid which, in the closed state, acts on the valve diaphragm by way of a holding-down means. This also results in excellent product protection during storage and/or shipping periods.

An advantageous development of the subject matter according to Claim 18 consists in that the plate part and integrally formed resilient attachment arms can be pressed against one another with closing action so as to prevent substance from escaping. Degassing can take place if need be. This is based on an iris-diaphragm-like construction, in that the plate part and the resilient arms attached thereto can be adjusted in relation to one another such that a closed state is achieved independently of the valve diaphragm. This is embodied, furthermore, in that integrally formed on the

plate part is a radially outwardly projecting closure shield against which the resilient attachment arm can be drawn with closing action and, furthermore, in that integrally formed on the holding ring and/or the wall of the dispensing container is an inwardly projecting closure shield against which the resilient attachment arm can be drawn with closing action. The control means here is such that formed on the resilient attachment arm is a guide flange which projects on the product side and interacts with a run-on slope of the wall of the dispensing container. A swing lid or the like is superfluous. The rotary handle may be formed by wing-screw-like formations of the holding ring, which is nevertheless of round outline here, said holding ring thus being given a further function to perform.

The subject matter of the invention is explained in more detail hereinbelow with reference to an exemplary embodiment illustrated in the drawings, in which:

Figure 1 shows, on an enlarged scale, a cross-section through a basic version of a self-closing valve,

Figure 2 shows, in section, the valve diaphragm on its own, still in the planar-surface state,

Figure 3 shows a section, corresponding to Figure 1, of a variant of the self-closing valve,

Figure 4 shows a plan view of the self-closing valve,

Figure 5 shows the center of the valve on an enlarged scale, showing a plate part secured via resilient attachment arms,

Figure 6 shows a container closure in plan view, with the swing lid open and a valve diaphragm not yet placed in position,

Figure 7 shows the section along line VII-VII in Figure 6,

Figure 8 shows a bottom view of the container closure, likewise with the swing lid in the open position,

Figure 9 shows an enlargement IX from Figure 8,

Figure 10 shows a vertical section through the center of the container closure with associated valve,

Figure 11 shows a lip position of the walls of the dispensing slit which brings about the air equalization,

Figure 12 shows a plan view of a modified plate-part arrangement,

Figure 13 shows this plate-part arrangement in section, and

Figure 14 shows a largely schematic illustration, in section, of a closing device including the pressure-absorbing spring.

The self-closing valve V has a valve diaphragm 1. This comprises a patch of elastomeric material with recovery properties.

The patch is punched out of a planar web, preferably in the form of a circular disc in outline.

Waste-free punching can be achieved with hexagonal punch cutting.

The center of the valve diaphragm 1 forms a dispensing region 2, which merges into a peripheral arresting region 3.

The dispensing region 2 of the valve diaphragm 1 is defined by a dispensing slit 4. The latter extends along the diameter of the valve diaphragm 1. It may be executed at the same time as the outline-forming punch cut and terminates at a sufficient spacing in front of the arresting region 3.

Starting from the planar intermediate state (see Figure 2), the valve diaphragm 1 is curved convexly (see, for example, Figure 1). The correspondingly convex shaping can take place in the mold utilizing a core configuration which follows the curved profile, the flexible patch being drawn against the curved surface, in the form of a spherical segment, in the arresting region 3. The valve diaphragm 1 is thus provided with a frame in the form of a peripheral holding ring 5 formed by encapsulation. Any possible, even anchorage-assisting peripheral crimping is enclosed.

The holding ring 5 is formed, in respect of the peripheral enclosure of the valve diaphragm 1, such that the valve diaphragm 1 of the self-closing valve V is curved towards the product side. The product is designated 6 and is of in particular liquid or pasty nature.

The convex curvature, as seen from the product side, causes the dispensing slit 4 to gape open on the product side. This produces a notch-like gap 7 in the dispensing slit 4. As can be seen, the equal-surface-area walls 4' of the dispensing slit 4 diverge in the direction of the product 6 which is to be dispensed. Use is made here of the curvature stressing which occurs as gap-forming fiber in tension. In contrast, on

the other side, that is to say on the far side of the so-called neutral fiber, a compressive action prevails, so that the edges of the slit walls 4'' butt against one another in the gap base 8. It is thus the case that the convex shaping is associated with the inner stressing to which the valve diaphragm 1 is subjected, especially since the valve diaphragm 1 is of convex shape throughout as far as the peripheral region 9.

In addition, the encapsulation of the holding ring 5 is carried out with such a diameter-specific undersize that this also provides an additional component for the curvature. Following the injection-molding operation, cooling additionally results in a shrinkage effect of approximately 1.7%. The said curvature is additionally enhanced somewhat as a result.

The holding ring 5 is shaped in a cross-sectionally U-shaped manner in order to enclose the peripheral region 9 including the outer periphery 10 of the valve diaphragm 1. The U-legs are designated 12, 13.

The U-shape of the holding ring 5 may be continued to form an additional mechanical arresting means, by securing spigots 11 extending from the inside of the U-shaped holding ring 5, these securing spigots engaging through the valve diaphragm 1, parallel to the periphery, over an extremely short path and preferably in close succession. Such a solution proves to be advantageous, for example, when, on account of corresponding material pairings, there is no intimate connection between the valve diaphragm 1 and the holding ring 5. The through-engagement openings for such securing spigots 11 are made, for example, in the form of cross-shaped punchings.

The U-legs 12, 13 of the holding ring 5, which are curved correspondingly at least at the regions of direct contact with the valve diaphragm 1, are of

different lengths. The U-leg 12 of the holding ring 5, which is directed away from the product 6, is the longer leg. The length ratio to the shorter U-leg 13 is approximately 3:1. While the shorter U-leg 13 terminates bluntly, the other U-leg 12 tapers in a lip-like manner, resting on the inner surface of the valve diaphragm 1. This longer U-leg 12 here provides a relatively large-surface-area, effective support in relation to the operational loading occurring in the direction of the arrow P. P corresponds to the dispensing direction. In this direction, the dispensing region 2 of the valve diaphragm 1 pushes out in the opposite direction to the basic position assumed, with the gap 7 correspondingly opening in a lip-like manner for the through-passage of the amount of product which is to be dispensed.

The positive dispensing pressure is applied to the dispensing container B, which has at least partially collapsible wall sections in order for the so-called squeezing actuation to be applied/exerted, and which can recover to the full extent.

The valve V is secured in the region of an end wall 14 of the said dispensing container B. The end wall 14 may be formed directly on the said dispensing container B or else on a container closure 15 associated with the dispensing container B, see Figures 7 and 10. The end wall 14 forms an accommodating chamber 16 for accommodating the valve V. The accommodating chamber 16 is provided in the form of a depression. Its base is designated 17. A common through-passage 18 for the product 6 which is to be dispensed and for the air equalization is located centrally therein.

The actual, preferably irreversible valve-arresting means is formed by a latching recess 19 of the holding ring 5. This latching recess merges into a blocking nose 20. This is positioned beneath a mating blocking

nose 21, which projects into the region of the accommodating chamber 16 and belongs to the correspondingly radially inwardly extended end wall 14 of the dispensing container B or of the container closure 15.

The back of the blocking nose 20 is provided with a run-on slope 22 which assists assembly.

The centrally located through-passage 18 is circumscribed, on the top side of the base 17, by an annular sealing bead 23 provided thereon. The underside of the valve diaphragm 1 presses, with slight resilient prestressing, against the cutting-edge-like crest of this annular sealing bead. A sealing location is thus provided here. The resilient action which can be obtained from the elastic material of the valve diaphragm 1, moreover, assists in the blocking-action flanks of the blocking nose and mating nose 21 engaging against one another. Accordingly, the valve V latches in perfectly. The abovedescribed arresting means also proves advantageous from a stabilizing point of view in that the latching recess 19 is associated with the U-web 24 of the holding ring 5. Use is made of the region with the greatest accumulation of material and polydirectionality.

The valve diaphragm 1 preferably consists of silicone. It is also possible, however, to use TPE. It is also conceivable for the valve diaphragm 1 to be produced with the holding ring 5 by two-component injection molding. The material selection may also be determined to the greatest extent by the product 6 which is to be dispensed, in particular also by the viscosity thereof. Instead of forming the valve diaphragm 1 from a blank of a homogeneous plastics sheet material, it is also possible for the plastics sheet material to comprise a multilayered structure. It is possible here to use in particular a combination of materials. It is, of

course, ensured that the individual layers are connected to one another in a sealed manner, so that product 6 is prevented from passing between the layers and escaping via the dispensing slit 4.

The self-closing valve V is then made more secure in a further area. This is embodied in the provision of a baffle associated with the valve diaphragm. It is thus no longer possible for the content, or product 6, which strikes against the head of the dispenser, for example, when the dispensing container B is positioned upside down, to escape. Rather, proper dispensing of a filling quantity is only possible by deliberate squeezing of the dispensing container B. For this purpose, the procedure is such that, on the product side, the valve diaphragm 1, at least the actual dispensing region 2, has a plate part 25 positioned beneath it.

The plate part 25 is of circular outline and is positioned beneath the valve diaphragm to leave an axial spacing. This forms a gap Sp in the mm range. Moreover, on its surface 26, which is directed toward the valve diaphragm 1, the plate part 25 is of (concavely) curved configuration in adaptation to the convex profile of the valve diaphragm 1.

The plate part 25 is of the same thickness throughout. Consequently, the surface 27, which is directed away from the valve diaphragm 1, is thus also curved convexly in adaptation to the convex profile of the valve diaphragm 1. This produces a laterally deflecting flow component in the case of impact of the mass of product 6. The corresponding dividing function all the way round in a radially outward direction may also be further enhanced, for example by the surface 27 having a more intensive curvature profile.

The plate part 25 is disposed such that it can be moved, preferably resiliently, relative to the valve

diaphragm 1. The corresponding resilient arms are designated 28. They function at pressure-absorbing springs. There are in total in each case three resilient arms 28, distributed at equal angles, in the region or space of the annular through-passage 18. The resilient arms 25 are of Z-shaped configuration, the Z-crossbar 29 following the central region of the annular through-passage 18, to be precise concentrically. Radially oriented attachment extensions 30 are positioned at the end regions of the Z-crossbar 29. These extensions form, as it were, the Z-legs. An inwardly directed attachment extension 30 is rooted in the periphery of the plate part 25; an attachment extension 30 of the same resilient arm 28 is positioned at the periphery of the sunken base 17 of the end wall 14, this periphery outwardly bounding the through-passage 18. This provides an integral connection with the container closure 15 and/or the dispensing container B.

However, with the exception of the resilient attachment arms 28, it is also possible for the plate part 25 to have a non-circular outline in plan view, this also applying to the holding ring 5, so that it is possible to cover a wide range of different cross-sectional container shapes.

In the case of the valve V being formed separately, use is made of the basic version in Figure 1, in which case, as has already been explained, the plate part 25 is added by way of the container closure 15.

The procedure is different for the variant which can be gathered from Figure 3: in this case, the valve is preassembled with the plate part 25. The designations from Figure 1 have been carried over analogously, in some cases without being repeated in the text. It can be gathered that it is also the case here that the dispensing region 2 has the plate part 25 positioned

beneath it, the gap Sp being left in the process. The functioning, otherwise, is virtually identical. The plate part is provided by injection molding, to be precise utilizing the formation of the holding ring 5. This supplies the material for the integral formation of the plate part 25 on the holding ring 5.

The corresponding arresting elements are, once again, securing spigots 31, as are discussed in respect of designation 11 and are formed in conjunction with the holding ring 5, in the U-space of the same. Either the Z-crossbar 29 of the resilient attachment arms 28, which are also realized here, and/or the likewise provided, radially oriented attachment extensions 30 form, by way of correspondingly selected cross-shaped punchings in the punched valve diaphragm, the through-engagement holes for the integral formation, which is, as it were, continued on the other side, of the attachment means or material bridges on the centrally located plate part 25.

The importance of the shrinkage action also has a bearing here, this resulting in increasing curvature, which assists the formation of the gap Sp, in respect of the plate part 25.

As can be gathered from Figure 10, the plate part 25 is attached to the holding ring 5 radially outside the dispensing slit 4 of the valve diaphragm 1. This radially outwardly directed spacing corresponds, for all practical purposes, to the through-passage 18, as has been discussed in respect of the basic version. The designation is used correspondingly. As is illustrated in Figure 10, it is possible for the dispensing slit 4, along a diameter extent, or diameter line, to project slightly beyond the region of overlap with the plate part 25. This provides venting-specific advantages in particular. It is also possible here to utilize the flexibility achieved for the valve diaphragm 1, since

the defined curvature is more like a shallow shell. The radius of curvature of the valve diaphragm 1 corresponds approximately to 0.8 to 1.4 times the valve diaphragm 1. In specific terms, the ratios in the exemplary embodiment illustrated are such that the radius of curvature of the valve diaphragm 1 corresponds approximately to a fifth of the chord height of the spherical-segment shell of the edge-secured valve diaphragm 1. The arc of curvature extends over a sector angle of 85°. The dimensions can be gathered, for example, from Figure 1, taking into account a scale of 10:1, on which Figure 1 is based.

Coming back to the container closure 15 of the dispensing container B, it can be gathered from the drawings that the container closure 15 has a swing lid 32. This is connected to a closure cap 34 via a film hinge 33. The closure cap 34 may be connected with sealing action to the neck of the dispensing container B via threaded engagement 35. Initial use requires a tamperproof seal 36 to be broken. The released position of the latter is illustrated by chain-dotted lines in Figure 7.

The swing lid 32 contains a holding-down means 37, which is in the form of a cross-shaped spike and is integrally formed along with the swing lid. In the closed state, this interacts with the valve diaphragm 1 with a position-securing effect. Good transit protection is thus provided. The act of the end side of the holding-down means 36 bearing on the inside of the valve diaphragm 1 is secured as a result of a swing-lid eyelet 38 being arrested on the pivoting-lever-like, stub-form tamperproof seal 36.

The entire arrangement is given good support from the inside by the unit which comprises the plate part 25 and resilient attachment arms 28 and functions as a pressure-absorbing spring.

Figures 12 and 13 show a solution with a similar effect, although in this case, instead of the resilient arms 28 in the form of annular sections, axially supporting springs 39 are used and/or act on the wall of the container closure 15 or of the dispensing container B. These springs are located at the free ends of three-pronged spokes 40 of the body, which in this case can be inserted from the product side. The wall has axially oriented guide grooves 41 accommodating the springs 39 and the ends of the spokes 40. This groove length is such that the resilient abutment is achieved, as is the displacement of the plate part 25, which moves back in the case of air equalization, in the direction away from the valve V.

Figure 14 represents the solution in the case of which the plate part 25 and integrally formed resilient attachment arm 28 can be pressed against one another with closing action so as to prevent substance or product from escaping. This closure operates by the axial displacement of lamellar elements. The closure manages without a swing lid 32. It can be opened and closed by rotation. For this purpose, the valve V, in the accommodating chamber 16 in which it is guided, is rotated via an angle of the holding ring 5. The holding ring 5 is given a further function to perform insofar as it has been developed into an actuating handle. Wing-screw-like protuberances 42 which are freely accessible for actuation provide a configuration which is favorable for gripping purposes. The plate part 25 and the resilient arms 28 attached thereto can be adjusted such that the closed state is achieved independently of the valve diaphragm 1. This is embodied, on the one hand, in that integrally formed on the plate part 25 is a radially outwardly projecting closure shield 43 against which the resilient attachment arm 28 can be drawn with closing action, and that integrally formed on the holding ring and/or on

the wall 44 of the dispensing container B is a radially inwardly projecting closure shield 45 against which the resilient attachment arm 28 can be drawn axially with closing action. It is possible for the resilient arm 28 to be configured as an encircling helix and to extend as far as the holding ring 5 and thus be drawn against correspondingly running blocking peripheries of the closure shield 43, 45.

The resilient attachment arm 28 has a mushroom-shaped configuration as seen in cross-section. It is, furthermore, widened to a considerable extent on the head side, so that it accounts for a relatively significant proportion of closing surface area in the region of the through-passage 18. A guide flange 46 performs the function of controlling the resilient attachment arms 28 for closing and opening purposes. This guide flange projects on the product side and effects its control via a run-on slope 47. The latter is seated on the wall 44 of the dispensing container B. The gradient of the run-on slope corresponds to the axially oriented closing stroke.

Such a closure can provide for degassing and also the abovedescribed intake of air for ventilation purposes.

Of course, the configuration of the self-closing valve V which has been explained within the context of a dispenser container is not restricted to the latter. Rather, the solution may also advantageously be used in other fields, for example for tank ventilation in a motor-vehicle tank-closure cap. With specific technical adaptation, it can even be utilized cost-effectively for bottles for babies or infants, bicycle bottles, etc.

It is also possible for the valve diaphragm 1 of the valve V to be provided with a hole-like dispensing opening rather than a dispensing slit 4, as is

explained in the introduction in conjunction with the cited document WO95/26306. Here too, a sealing plug of the plate part 25, forming the elastic and/or resilient supporting element, will engage in the central dispensing opening.

All features disclosed are (in themselves) pertinent to the invention. The disclosure contents of the associated/attached priority documents (copy of the prior application) are hereby also included in full in the disclosure of the application, also for the purpose of incorporating features of these documents in claims of the present application.